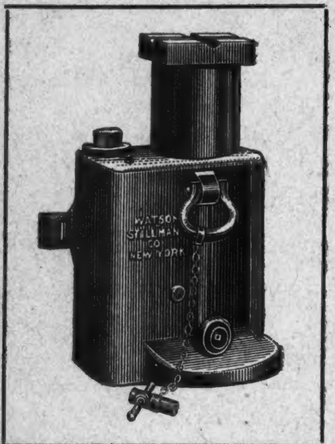
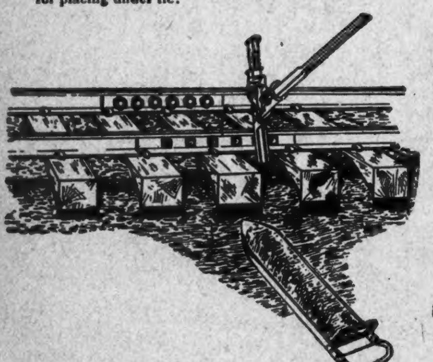
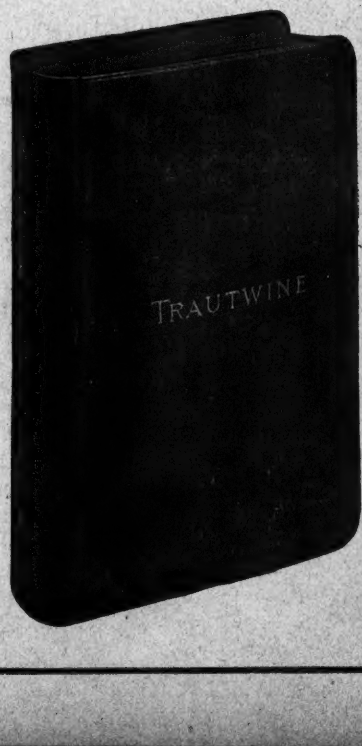
RAILWAY ENGINEERING

AND MAINTENANCE OF WAY

Vol. IV JULY, 1908 No. 7



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Railway Engineering

and Maintenance of Way

PUBLISHED BY

CRANDALL PUBLISHING COMPANY

BRUCE V. CRANDALL, President WARREN EDWARDS, Vice-President C. C. ZIMMERMAN, Secretary
NORMAN F. REHM, Editor

OFFICE OF PUBLICATION: Security Building, Cor. Madison St. and Fifth Ave., CHICAGO **Telephone Main 3185**

Entered as Second-Class Matter April 13. 1905, at the Post Office at Chicago, Illinois, Under Act of March 3, 1879.

CHICAGO THE LOCATION FOR A RAILWAY PAPER.

The Railway Lists show 766 addresses of railway officials in Chicago as against 665 in New York. Fully one-half of the New York addresses are of financial officers, who are not active railway men; while nearly all of those in Chicago are active in munagement and operation.

Chicago is the greatest railroad center in the world, being the terminal of 34 railroads having an aggregate mileage of 91,627 miles, or more than 40 per cent of the entire mileage of the United States. Of these 34 railroads not one sends a train through the city; Chicago is an absolute terminus which can be said of no other city in the country. More sleeping cars, on through trains, are scheduled to arrive at Chicago in the morning and depart in the evening than any other city in the world.

More railway meetings are held in Chicago than in any other city in the country. Chicago is headquarters in everything relating to railways. It is the center of railway activities, railway news and railway purchases. It is the proper location for the greatest railway journals in the world .

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Corner Madison St. and Fifth Ave.
CHICAGO
Telephone, Main 3185.

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.

In remitting, make all checks payable to the Crandall Publishing Company.

Papers should reach subscribers by the tenth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

Vol. IV. Chicago, July, 1908 No. 7

CONTENTS

Railroad Accidents

THE number of accidents to railroad employees and passengers has not been decreasing materially with improved construction and equipment. During the recent period of decreased traffic there was, however, a diminution in the number of accidents to employees, but this is thought to be due mainly to the reduction of overwork and excessive hours and also to a weeding out of the less competent men.

While attention has been given to the elimination of the personal factor as far as is possible in railroad operation with the object of decreasing the number of collisions and derailments as well as making the operation of trains less dangerous to employees, mistakes and also forgetfulness and recklessness will always give rise to many accidents.

It is expected nevertheless that the number of accidents will decrease with the ever increasing safeguards which the railroads of this country are adopting. It is to the advantage of the railroad company, its employees and to the public in general and on this account the work of improvement in construction and operation will steadily advance.

Concerning the Life of Ties

THE experimental work with railway cross-ties, which is being instituted by the Forest Service, U. S. Department of Agriculture, is to determine the available tie timber for the Northern Pacific Railroad and the best processes and methods of manufacturing the ties. This investigation will result in a more economic use of timber and therefore it is a step toward the solution of the tie problem.

Seasoning tests were conducted at Tacoma, Wash., and Landpoint, Idaho. The climatic conditions at these two points vary widely, but the average rate of seasoning for the Northwest is given by the average of the two stations. Besides determining the green weight and rate of seasoning of timbers cut in several months, a record was taken of the absorptive power of seasoned timbers. It was found that hewed ties, peeled when cut, season more rapidly than unpeeled ties during the first four months, but that the weights of peeled and unpeeled are about uniform at the end of a year. It was also found that hewed ties peeled immediately before treatment absorb more of the preservative than ties peeled when cut.

In order to determine the durability of timber under the same conditions two test tracks were constructed, one about 6 miles west of Hot Springs, Wash., and the other on the main line of the Northern Pacific about 2 miles west of Plains, Mont. Common spikes and screw spikes were arranged in various ways to cover a large number of conditions. Flat and flanged plates, also wooden plates, were used in order to obtain a complete record of the value of each in increasing the life of the tie. The ties used in the tests were

of Douglas fir and tamarack; green, seasoned and creosoted ties.

The consummation of these tests on the manufacture and preparation of the ties and the effect of the various designs of spikes and plates will lead to a means of overcoming tie failures due to decay and cutting.

New Appliances

THE inventions of new railroad appliances are steadily increasing. More particularly for the track department is this true. Each issue of the Patent Office Gazette contains records of new designs of rail joints, frogs, ties, etc. Many of these devices showing any degree of merit are tested to service, but few prove requisite to improved construction.

Unless the device proves itself to be a necessary adjunct to improved construction, it is difficult to secure the adoption of it by any railroad even though it may contain some very commendable features. It becomes essential in the end to have the device placed on the market by a supply company capable of forcibly explaining its advantages and placing it in competition with other devices of more or less merit.

Then again it is evident that the railroad engineer has not the time to investigate carefully the many new designs. It is a fact that he will not take haphazardly the advice of inventors and promoters. In consideration of these points it is an easy matter to see the difficulties which the inventor must overcome if he is ever to have his device adopted.

The Maintenance of Way Association

THE various committees of the American Railway Engineering and Maintenance of Way Association have entered upon their work for the ensuing year. The initial meetings of several committees have been held and the detail work more carefully outlined.

The Committee on Records, Reports and Accounts prepared circulars requesting information on the subject of Estimate Forms and on the subject of Time Books. The committee on Wood Preservation appointed sub-committees on Statistics and Economics, Preservatives, Adaptability of Woods and their Preparation and Treating Processes. The committee on Rail appointed three sub-committees on Experiments and Tests, Sections and Specifications, and Rail Service. The committee on Ties appointed sub-committees on Compilation of Statistics, Timber Supply, and Metal Ties. The committee on Track prepared circulars for information and appointed various sub-committees in connection with its work.

An outline of their work is contained in Bulletin No. 99 of the Association, indicating that the reports for the convention in March, 1909, will be carefully prepared.

Claims for Loss and Damage to Freight

IN a paper presented before the St. Louis Railway Club, Mr. S. P. Webster, freight claim agent, Terminal Railroad Association of St. Louis, discussed briefly the causes and sources of claims for lost and damaged freight. He pointed out that attention has been given chiefly to forms of adjustment for claims and that prevention of claims has had comparatively little consideration. He called attention to the employment of incapable men for yard clerks, receiving clerks, loading clerks and bill clerks as well as an insufficient number of them. He mentioned many other causes and sources which give rise to an aggregate of claims, approximating $20,000,000 per annum.

In the conclusion he advocates that the remedy lies in overcoming the causes of the claims and notes that the function of the freight claim agent is only the adjustment of claims.

Concrete in Track Construction

WITHIN the past eight years, a large number of concrete ties have been designed and tested on main lines. Several of these designs have stood the test of service for three or more years and may prove to have a longer life than the wooden tie, yet it can not be said that the concrete tie has shown itself to be an economic proposition up to the present time. If the timber supply should so decrease that the cost of the wooden tie would rise exceedingly, then it is possible that the concrete tie, as now designed, might compete favorably with the wood tie.

In a recent issue of The Concrete Review there is an article by R. D. Coombs on the subject, "Concrete in Railroad Construction." He discussed the various requirements of the concrete tie, its advantages and disadvantages, and expressed the opinion that the cost of wooden ties would increase for some years to come and that this would make the concrete tie of greater cost and longer life a commercial possibility. With this article Mr. Coombs also included an illustrated review of the various concrete ties and as far as was possible gave data on service tests.

Size of Drawings

THE size of standard drawings is usually specified with a view toward uniformity that will afford convenience in handling and filing as well as clearness. In all cases it would not be well to follow definitely prescribed rules as to size and arrangement, but the matter is worthy of some consideration. Frequently plan and detail drawings are placed on the same sheet to facilitate handling, when the drawings are of small size.

The variation in size of standard drawings of the same device is shown by the following comparison of the plans of two different railroad companies. In one

case the sheet measured 4x8½ ins. and the scale of the drawing was ½ in. to a foot, while in the other case the sheet measured 30x50 ins. and the scale of the drawing was 3 ins. to a foot. This example is given as an illustration of extremes, the smaller drawing lacking clearness and the larger being unhandy.

The same opinions are not held by everyone regarding the best sizes for drawings, yet it does not seem that any consideration is given the matter in some cases.

New Thirty-Stall Roundhouse at East Buffalo, N. Y.

New York Central & Hudson River Railroad

THE New York Central and Hudson River Railroad recently completed the erection of a new 30-stall roundhouse at East Buffalo, N. Y. It is located west of the old 28-stall West Shore roundhouse. On the site of this old 28-stall roundhouse it will be possible to erect in the future a 50-stall roundhouse to be used in connection with the new 30-stall roundhouse.

In the accompanying plan the proposed future extensions of all buildings are shown in broken lines. The coal handling plant will be enlarged and another depressed ash pit will be built.

The present buildings are located between the main line tracks of the West Shore Railroad and the Pullman Parlor Car Works. Provision is made to turn outgoing engines either to the east or west, as desired, the tracks leading in both directions from the turntable pit of the new roundhouse. Incoming engines enter from the east on tracks parallel to the West Shore main line tracks and pass over the depressed ash pit shown on the plan.

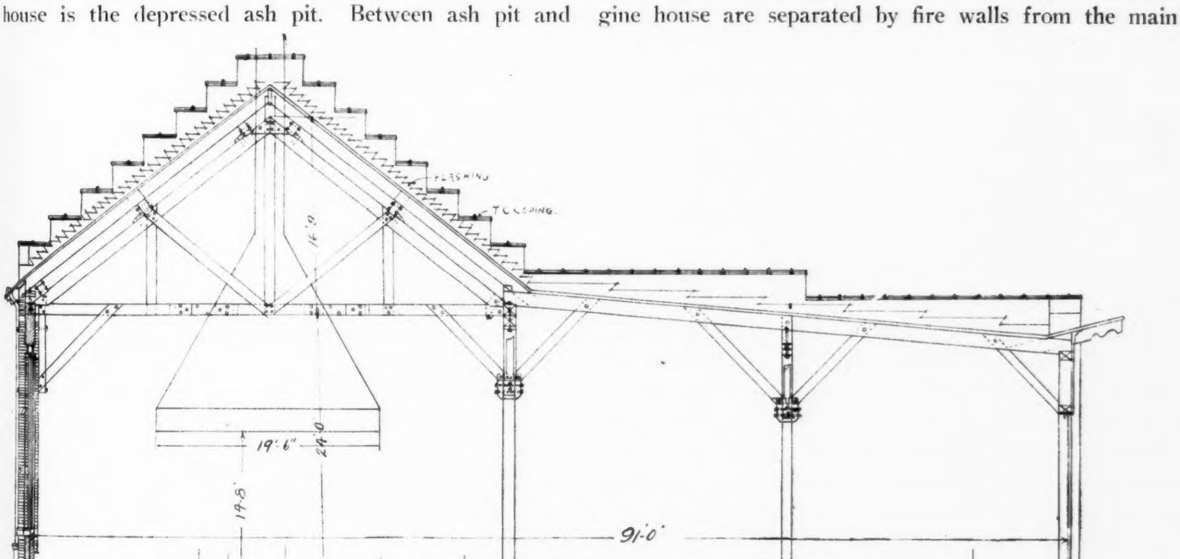
A mechanical coaling plant is located about 650 ft. from the turntable. Between this plant and the roundhouse is the depressed ash pit. Between ash pit and coaling plant and to the north of the tracks for outgoing engines is a 50,000 gallon water tank. Water columns are located between tracks opposite the tank.

ROUNDHOUSE.

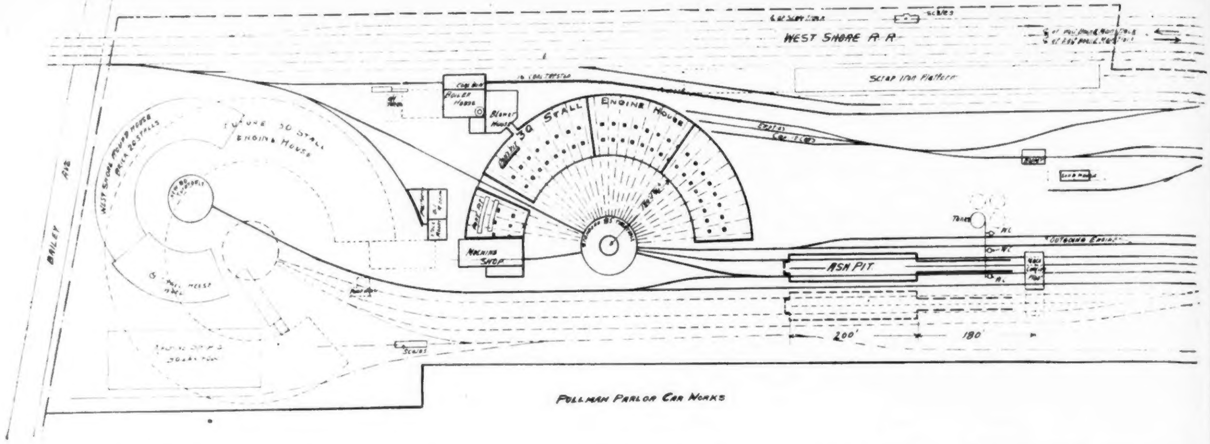
The roundhouse is of the standard New York Central design. A typical cross-section through the locomotive and drop pits is shown herewith. The building has a depth of 90 ft. and the distance from inner wall to center of turntable pit is 130 ft. 1¾ ins. An 85-ft. turntable turns engines to tracks radiating at an angle of 5° 44′ 52″ from center of pit.

The principal dimensions of the roundhouse are shown in the drawing. The wall columns are of cast iron and the interior columns are of 10x10-in. or 12x12-in. timbers. The floor and also the column and wall footings are of concrete. The roof is constructed of rafters, supported by wooden truss and columns, on which 2x10-in. planks are laid.

The working pits are 67 ft. 9½ ins. long, being 15 ft. 2 ins. from the outer wall and 8 ft. ½ in. from the inner wall. Three stalls in the west wing of the engine house are separated by fire walls from the main



NEW THIRTY-STALL ROUNDHOUSE AT EAST BUFFALO, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.



GENERAL LAYOUT OF LOCOMOTIVE TERMINAL AT EAST BUFFALO WITH POSSIBLE FUTURE EXTENSION SHOWN IN BROKEN LINES, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

building. These three stalls are provided with pony, driver and tender pits. Three end stalls in the main building are also provided with pony pits. The truck wheel and driver drop pits are connected by tunnel, in which there is a narrow gauge track for the transfer carriage.

MACHINE SHOP.

The machine shop adjoins the engine house, as shown on the plan. It is connected with the wing of the house, which is provided with drop pits. One track leads from the turntable to the machine shop. The floor space is about 4,500 sq. ft.

Mr. Frank M. Steel was appointed master mechanic at East Buffalo in March, 1908. For the previous year he had been road foreman of engines.

Reinforced Concrete Piles and Cross-Ties

THE substitution of reinforced concrete for wooden piles and cross-ties was the subject of a paper presented by A. H. Chenoweth before the New York Railroad Club. An abstract of the paper is given in the following paragraphs:

Reinforced concrete piles were first introduced in Europe about 1900. They were cast in forms with a square cross-section and reinforced in the four corners with steel bars tied together every six inches of the length of the pile. These piles were driven by a hammer, using a driving cap with a cushion. They were limited in their length and diameter, lacking proper distribution of steel reinforcement. This same argument applies to piles constructed in place, since designed.

I have the honor of presenting to you a method of construction, using no forms, producing a reinforced concrete pile by simply rolling a sheet of concrete and metal netting into a solid cylinder. Piles thus manufactured can be made in long lengths and a wide range of diameters.

The compressive value of concrete is many times greater than its tensile strength, while it is just the reverse of steel. In this construction the reinforcing members act independently, the concrete carrying the load action under a compression stress, while the steel reinforcement resists the tensile stress.

The pile is made up of a steel pipe or rod, a coiled sheet of wire netting and longitudinal steel rods, placed near the periphery, equal distance apart, parallel to the longitudinal axis of the pile. The pile or rod forms the shaft or mandrel on which the pile is rolled or wound and the netting and rods constitute the reinforcement.

The apparatus for rolling the pile consists of a traveling platform between which and the roller the pile is formed. The winding pipe or mandrel is set in line of the shaft of a large spur wheel. In operation the steel wire netting with the longitudinal rods attached is spread on the platform and covered with a layer of concrete. One edge of the netting is attached to the edge of the platform, and the other edge to the winding pipe or mandrel. Thus arranged the winding mandrel is rotated and the netting and its covering of concrete is wound or coiled up. At the same time and as fast as the netting and concrete is coiled up, the platform moves under the roll and the roll itself rotates.

The forming cylinder or concrete is by this means kept under constant and heavy pressure between the platform and roller. To bind the roll of concrete, wires are wound around it as close intervals and tied. The wires are contained on spools arranged beneath the moving platform. These spools are spaced every six inches along the pile and fastened to the wire mesh, so that when the pile reaches the lower edge of the platform it can be revolved about the axis, causing the wire to be wound on the pile. In this manner the wire is passed around the pile a number of times and secured. At the driving end of the pile the spools are placed four inches apart for the first six feet of the pile and then six inches apart for the remainder of its length. The pile is removed from the machine by rolling on to a car, when it is transported to a platform where the point is formed, flushed up or smoothed, if desired, and allowed to remain until it hardens.

By this method piles of all lengths and diameters can

be made. The diameters of the reinforcing rods have been determined for all lengths up to 61 ft.; also the ratio of the diameter of the pile to the length of pile by actual experiments.

This form of reinforcing is well adapted to resist tensile strain due to eccentric loading. It may be called a hopped column, the properties of which have been well defined by Prof. W. K. Hatt.

This pile is able to withstand rough treatment in handling and driving. Its bearing capacity is four times greater than that of a wooden pile. A pile 61 ft. long, 13 ins. in diameter can be suspended in the middle, dropped from platform cars, rolled down an embankment and driven in the hardest kind of material. It shows a remarkable degree of elasticity.

A pile 61 ft. long and 13 ins. in diameter was recently driven before a committee of experts at a place known to be particularly difficult to penetrate, located near Greenville, in this harbor. The material was mud and compact gravel. The pile was given some four hundred blows with a hammer weighing 3,600 lbs., and driven until it refused, with ten blows with a drop of twenty feet, to move farther. It was then decided to hammer it to destruction. The blows were continued with a brooming of the head. The pile was pulled up and examined and found in perfect condition. The head was broomed for 20 ins. The verdict was that the pile had withstood the severest test, far beyond the endurance of a wooden pile, without failure. The penetration into the gravel was 8 ft., the pile having an area four times greater than a wooden pile.

The committee adjourned to make a land test. A place was selected where it was known to be a fill some 40 ft., consisting of old canal boats, crib work and boulders. A pile 45 ft. long was selected and a hammer weighing 2,500 lbs. was used. The pile with 170 blows moved until a timber obstruction was reached. After repeated blows it refused to move with a 20-ft. drop. The committee decided that a timber obstruction was reached and a heavier hammer, weighing 4,600 lbs., was called into service. The head of the pile was squared up and with blows with the new hammer, 10-ft. fall, the pile penetrated the obstruction and was driven to the surface without reaching rock, which was thought to be about 43 ft. below. The treatment given this test was also decided to be more than a wooden pile could possibly stand.

Piles of this construction have been used in the foundation of the pumping and electrical power house of the Erie Railroad at Susquehanna, Pa.; also in the station platforms of the Brooklyn Rapid Transit Railroad, Brighton Beach and Coney Island division, at Avenue A, Greenfield avenue, Kings Highway and Sheepshead Bay.

A driving cap is used consisting of a cylinder of steel with a diaphragm midway between ends. This is placed on the pile with a coil of rope as a mat, below diaphragm, sawdust and a wooden follower block.

The mixture used for concrete is one of cement, two of sand and three of gravel. This proportion appears to give the best results.

Concrete piles constructed in 1900 were driven in the foundation of coal pockets at South Hampton, England. Recently it became necessary to shorten them after being exposed for eight years to salt water and tidal changes. They were found perfect and the steel reinforcing members one-quarter of an inch below the surface were not corroded and were in good condition.

CROSS-TIES.

The reinforcing of concrete to resist impact suggested the same form of construction to be applied to a railroad cross-tie or sleeper. This selection has been well established by severe test now being conducted on the Pennsylvania line west of Pittsburg at the Scully yard, where the cross-ties have been in the track for two years. The Interborough Rapid Transit, New York City, has some in the west track at Dyckman street station, which have been in place since July, 1905. The Philadelphia Rapid Transit have some ties on their Walnut street surface road. They so far give satisfaction, having received no complaint.

At the Scully yard Mr. W. D. Wiggins, Esq., Engineer of Maintenance of Way, under a report dated April 24, 1908, states:

"Several of the ties have been damaged by derailed cars, but have not been broken."

Some explanation of the form of this tie, which is made in the same way as the pile before described, being a roll reinforced. The roll is placed in a form and squared by pressure and a mixture of sand and cement. The holes for the fastening device are made by steel pins being pressed through the tie by means of a template. They are exact. The pins are withdrawn before the tie hardens. The fastening device for fastening rail consists of a small shell of galvanized steel coiled into a hollow frustrum of a cone. Into the large end of the cone is inserted a spiral spring of proper pitch to mesh with threads of a ¾-in. commercial lag screw. The shell with spring is inserted in the conical hole at bottom of tie. The lag screw is passed through a clip engaging the flange of the rail and screws into the spiral spring until the rail is tightly clamped to the tie. In practice a hard wooden block is placed below the rail. This deadens the shock. In the case of the Interborough Rapid Transit road, and also the Philadelphia Rapid Transit, the block has stood and shows no deterioration, although one-half inch thick, in the case of the first road mentioned.

The block used on the steam road at Scully had to be renewed, as the rail cut into the blocks in a very short time. I suggested a steel tie plate be placed on top of the block. The plates were ordered, not before some of the wooden blocks had been cut through, leaving the rail to pound upon the concrete tie. The effect was to damage the tie under the rail, which was observed on four of the ties, about 2 per cent. This Scully track deserves some notice. There was no indication of any track force

ever having given it much attention, being used to transport freight and coal cars. Iron from Carnegie Iron Works, trains loaded, moving over the line every five minutes, day and night.

The lifetime of a wooden tie has been given as from six to eight years, due to decay largely and to crushing from heavy loads. Concrete ties would be indestructible and cost very little more than wooden ties, when manufactured by the railroads themselves.

In practice concrete ties should be placed about 10 ins. apart, with a wooden block under rail. This wooden block in steam roads should have a steel plate on top, below the rail, to increase the bearing surface of the lower flange of rail. The rail should not be less than 100 lbs. per yard. In electric or street roads, the steel plate can be omitted.

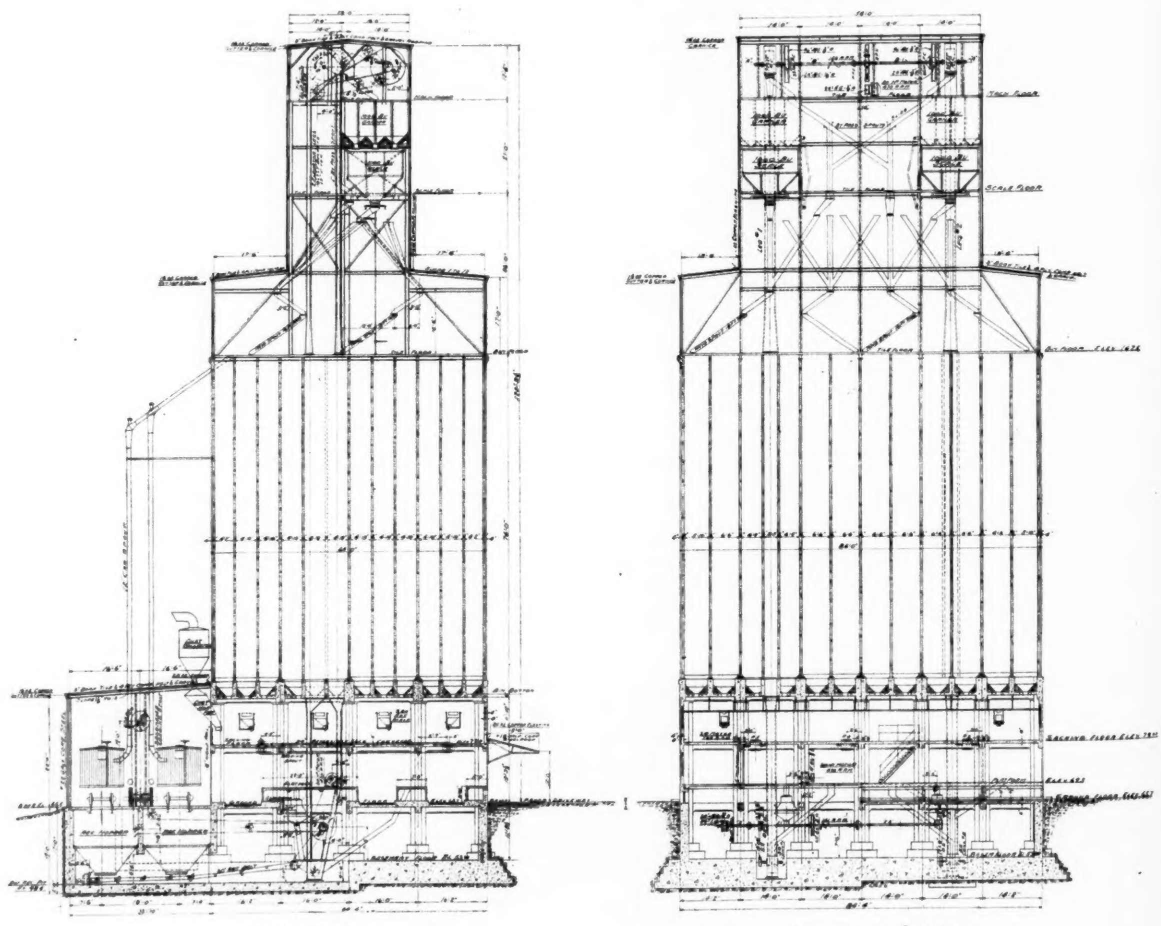
Mount Clare Grain Elevator, Baltimore, Md.

Baltimore & Ohio Railroad

THE Baltimore & Ohio Railroad Company is building a modern grain elevator for handling local business at the Mt. Clare yard, Baltimore, Md. It will have a capacity of 250,000 bushels, but it is designed so that the capacity can be doubled at any time that the volume of trade warrants it and so that the present building and the addition when made can be operated as one building. James Stewart & Company, of Chicago, have the contract and work is now well advanced. It is expected that the elevator will be completed and ready for use by September 1, 1908, and it will take the place of the one that was destroyed by fire August 8, 1907.

The lower stories and bins of the structure are being built of reinforced concrete; the cupola and track shed have structural steel frame work; metal windows will be used throughout and the structure will be as nearly fireproof as it is possible to make it.

The walls of the cupola and track will be of reinforced concrete thus giving the entire structure a uniform and sightly appearance. It will be divided up into 134 bins,



SECTIONS THROUGH MOUNT CLARE GRAIN ELEVATOR, BALTIMORE & OHIO RAILROAD.

there being a number of small bins to take care of the "identity preserved" grain.

The house will be served by two tracks running through the covered shed. Under each of these tracks will be located two 1,600 bushel car pits. Two pairs of Clark automatic grain shovels are provided to unload the cars from either track. A duplex capstan car haul is located at one end of track shed for spotting cars over the pits. Grain will be carried from these pits to the two elevating legs by two 30-in. belts.

The ground floor of the workhouse will be used for teaming, three paved driveways being arranged between the supporting columns of the house and baggage platforms located between these driveways. There will also be a paved driveway 25 ft. wide along the outside of the work house. This driveway next to the building will be protected by an overhanging roof.

Above the sacking floor eight portable Richardson automatic scales are suspended on overhead tracks for weighing automatically and sacking direct from the bins.

On the sacking floor are three reversible sacking conveyors to carry the sacks to any of the openings located over the driveways, from whence the sacks are spouted direct to wagons.

Two bucket elevators elevate the grain to the cupola where there are two 1,000 bushel Fairbanks self-registering scales with two garners of equal capacity above.

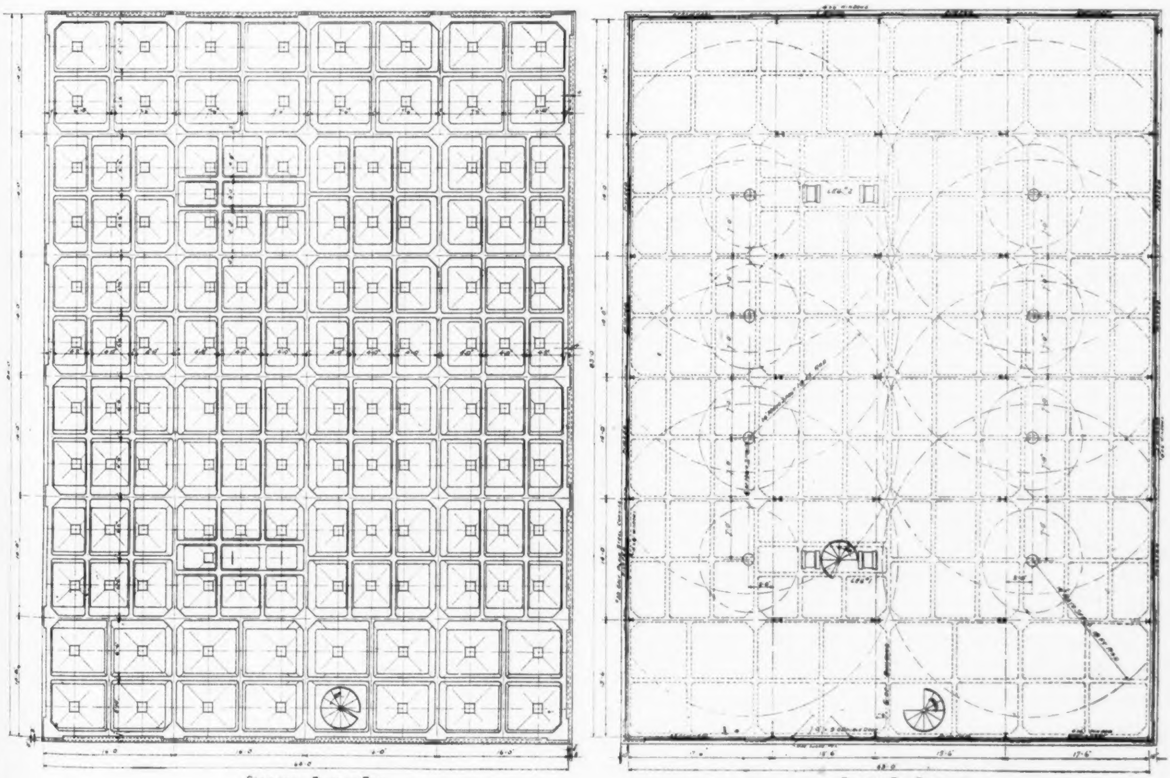
From the scales, the grain is discharged into any bin by means of Mayo distributing spouts.

For shipping purposes two car spouts are provided, one to serve each track.

MOUNT CLARE GRAIN ELEVATOR, B. & O. R. R.

The house and machinery is so designed that grain can be transferred from any bin to any part of the house in one operation.

The machinery will be driven by induction motors. The house will be fully equipped with modern up-to-date



PLANS OF BINS AND BIN FLOOR OF MOUNT CLARE GRAIN ELEVATOR, BALTIMORE & OHIO RAILROAD.

machinery such as self-registering scales, complete pneumatic dust collector, aspirators, etc.

Mr. D. D. Carothers is chief engineer and the work is under the direct supervision of the company's architect, Mr. M. A. Long.

Waterproof Concrete

WE have heard it said by engineers that such a thing as perfectly water-tight concrete is unobtainable in practice. This, we think, is too pessimistic a view to take. That such a concrete is not often found we grant, for the fact is forced upon our notice too frequently to leave any room for doubt; but that it cannot be obtained if suitable materials be used and sufficient care be exercised in its manufacture, is another matter. That it may not be easy to produce impervious concrete under ordinary conditions of work we readily admit; but, after all, we think its production is very much a matter of training, and is within reach, if only certain points be kept in view, and definite lines are rigidly followed. In support of this we know that only a few years ago, when it was the custom to lay concrete much dryer than it is at present, the impermeability of the material was much less than it is now, the cause of the change being that much wetter mixtures are now employed, with the result that the concrete is of a far denser nature than was previously the case. We all know how, with the advent of reinforced concrete, wetter mixtures came into vogue, and the impermeability of concrete increased. If this practice be carried a step farther, beneficial results arise. If we make sure that all the materials are so proportioned that no voids are left unfilled by cement, and that thorough mixing is performed, we go a very long way towards obtaining a concrete which is water-tight. Another factor also, which no doubt conduces to this end, is that in reinforced concrete the proportion of cement is also larger. Now if this improvement in the impermeability of concrete is noticeable where no particular efforts are made towards that end, surely if special precautions are taken much better results should be obtained.

Concrete may be made so dense, or of such a close texture, that it will, from the commencement, not allow any water to pass through it, or it may be made less dense, so that there are small seepage channels through which the water may find its way. These channels may, however, be so minute that the exceedingly fine particles of matter generally held in suspension by the water may soon choke them up, and from that time render the concrete water-tight. The same result may also be attained in, perhaps, a quicker way by mixing with the water some material, such as fine clay, which will quickly fill up all the seepage channels and produce a water-tight job.

The manufacture of initially impervious concrete requires, as we have before stated, great care; and the difficulty of so proportioning the stone, the sand and the cement, so that there are no voids unfilled, is of no less importance than the absolute necessity there is that the materials should be so thoroughly mixed that the cement is distributed throughout the mass. If this be not done, seepage channels will be left and water will surely find these out. It is owing to the varying care exercised in these particulars that a mass of concrete made up of different batches often shows varying degrees of porosity, some portions being, perhaps, perfectly dry, while others may almost be said to "leak like a sieve."

Where seepage channels occur the time occupied in closing up, if they ever do close up, of course depends on their size, and on the nature of the water which passes through them. In the case of some large reinforced-concrete water pipes which were made for use on the United States reclamation work in California, and which had to withstand considerable pressure, attempts were made to close up seepage channels in the pipes by introducing various substances into the water and forcing it through the channels in the hope of closing them up. Only a measure of success, however, attended these efforts. It was found that although the channels did gradually close up, before this took place the waste of water through leakage was very considerable. Some engineers are of opinion that the water under pressure dissolves some of the material forming the concrete, which it deposits in a stalactitic form near the outer surface of the concrete, the pressure of the water there being less than on the inner surface. We do not think, however, that too much reliance should be placed on this property; for, although there is little doubt that water will to some extent dissolve the material in its passage, and deposit it before issuing from the concrete, there is not much certainty about the process, and it is far better to place faith in the proper proportioning of the materials used in the concrete, the fine grinding of the cement, and, above all, in the most thorough mixing of the constituent parts. These points having been carefully attended to and the mixture made sufficiently wet, a thoroughly water-tight concrete may be expected as the result.

There are engineers and architects who do not appear to appreciate the fact that it is far better to do all that is possible to make the concrete which they use practically impervious to water than to employ elaborate after-methods of water-proofing, in the shape of asphaltes, cements, etc., plastered over the surface, and they seem to regard the subject in a sort of fatalistic way. They apparently entertain the belief that, do what they will, their concrete is bound to let water through and, instead of doing all that is possible in the initial stages, they act when in difficulties rather like the man in the fable who called Jove to his assistance instead of helping himself: Jove, in the case of the engineer and architect, being the maker of various bitumistic or cement waterproof compounds, which are supplied at considerable expense to the surfaces of the foundations and walls. When these asphaltes and waterproofing substances are used, we believe one of the best methods of application is to place the material, in the form of sheets, in the interior of the

wall when the latter is built. When not placed in this way the opinions of engineers differ very much as to whether the outside or the inside surface of the wall should be covered with the waterproofing material. Excellent, however, as many of the bitumistic compounds on the market are, it seems a pity that more efforts are not made to render the concrete itself waterproof, either by the care with which it is made, or by the addition of certain well-known substances which, when mixed with the cement, have the property of making the concrete impervious to water. Of these two methods, the former is probably the better one, and should be practised more carefully than it is.—Engineering, London.

Inspection of Signals and Signal Apparatus

ON the Lake Shore & Michigan Southern Railway, all detail inspection of signals and signal apparatus is conducted by four headquarter's inspectors. Two of the inspectors perform all detail inspection referring to maintenance, one inspector takes care of all construction work and one inspector performs all detail work as directed and takes care of all testing of material and apparatus.

Forms are used by the inspectors on the details of maintenance to return their reports to the main office. Form No. 2849 is used to report an automatic signals and crossing alarm bells. The headings for the various columns of this report blank are as follows: Signal number, location, lamps and roundels, pole semaphore and castings, machine, track batteries, relays, wiring, line wire, bonding, boot legs and connections, cross-over circuits, fouling and switches, switch boxes and indicators, lightning arrestors, S. & L. movements, engine and generator, power house, charging switches, and remarks.

Form No. 2850 is used for reporting on cut out derails, facing point switches and train order signals. The column headings on this report blank are as follows: Location, facing point switch or train order signal, siding derail, condition of point when closed, cranks, switch stand, pipe line, pipe carriers, ties and rail braces, connections at switch pole and castings, wire line, levers, glass and lamps, and remarks.

Form No. 2852 is for the inspector's report on power interlocking. The column headings on this report blank are as follows: Switch number, derail number, signal number, pole charges, motor, machine, switch and derail points, detector bars, wiring, batteries, tie and rail braces, relays and magnets, up and down rods, pole and castings, glass and lamps, circuit breakers and remarks. At the bottom of blank, there are lines crosswise of blank for information relative to tower, power house, machine and locking slots, annunciator, electric locks and motor.

Form No. 2851 is for the inspector's report on mechanical interlocking. The column headings are as follows: Switch number, derail number, signal number, S. & L. movement, cranks, compensators, lead outs, pipe line, ties and rail braces, detector bars, bolt locks, switch and derail points, wire line, pole and blade and castings, up and down rods, glass and lamps, bonding and insulating and remarks. At the bottom of blank are lines crosswise of blank for information relative to tower, lamp and oil house, machine and locking, slots, annunciators and repeators and electric locks.

Timber Supply

THE need of National forests has become more prominent in recent years and this is emphasized by the agitation of forestry experts who realize fully the approaching conditions in our timber supply. The following table is taken from a bulletin of the Forest Service by Mr. Treadwell Cleveland, Jr., in which he describes the conditions of forestry in European countries and points out the lessons which they should teach us.

Country.		Total net revenue from Government forests.	Expenditure per acre.	Net revenue per acre.
Württemberg		$3,096,428	$2.05	$6.60
Saxony		2,299,000	3.00	5.30
Baden		829,162	3.58	4.42
Hesse		744,209	1.25	4.29
Switzerland		237,663	1.32	2.55
Prussia		17,054,144	1.58	2.50
Bavaria		5,128,348	1.99	2.22
France		4,737,250	.96	1.75
Italy				.33
Hungary			.34	.32
Austria		5,313,000	.56	.21
Roumania		482,600		.18
Spain				.17
Sweden		1,677,672	.02	.09
Russia		21,500,000	.01	.032
United States	1905-6	[b] 12,000	.007	[b] .0001
	1906-7	128,659	.0093	.00086

[b] Deficit.

In the first place the table shows that forestry pays and that it pays best where large expenditures are made in the management. The United States has appropriated very little and therefore the returns have been small.

Country.	Imports.	Exports.	Country.	Imports.	Exports.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Great Britain and Ireland	9,290,000		Mauritius	20,000	
Germany	4,600,000		Servia	15,000	
France	1,230,000		Ceylon	10,000	
Belgium	1,020,000		Japan	5,000	
Denmark	470,000		West India, Mexico, Honduras, etc.		13,000
Italy	420,000		West Coast of Africa		28,000
South America	330,000		India		56,000
Spain	210,000		Roumania		60,000
Egypt	200,000		United States		1,080,000
Holland	180,000		Norway		1,040,000
Switzerland	170,000		Dominion of Canada and Newfoundland		2,144,000
Australasia	160,000		Austria-Hungary		3,670,000
Cape of Good Hope	150,000		Sweden		4,460,000
Portugal	60,000		Russia, with Finland		5,900,000
Natal	50,000				
Bulgaria	50,000		Total	18,725,000	18,390,000
China	50,000				
Greece	35,000				

[a] From tables in Schlich's Manual of Forestry, vol. 1, 3d edition.

The second table shows the net wood imports and wood exports of forest countries, giving the average data calculated from returns of five years.

It is needless to say that the forest resources of the exporting countries are in many cases gradually diminishing. The United States is consuming three to four times the wood which its forests produce and is nevertheless giving less attention to National Forest preserves at the present time.

Cast Iron and Reinforced Concrete Culvert Pipe

CONCRETE and reinforced concrete culverts have been used extensively in the past few years in railroad track construction and on this account an investigation of the action of pipe under various conditions of loading was conducted by Prof. Talbot of the University of Illinois. The chief tests were made by the Engineering Equipment Station, being published in Bulletin No. 22.

The section of the bulletin relating to Resisting Moment and Calculation of Stresses and also the section on General Comparison of Results are given as follows:

RESISTING MOMENT AND CALCULATION OF STRESSES.

For a ring whose thickness is small in comparison with the diameter the difference in the length of the inner fiber and outer fiber is small and the expression for the resisting moment given for ordinary straight beams may be applied with a close degree of approximation. In the following formulas the length of the ring (width of beam) will be considered unity. Call t the thickness of the ring.

For the rectangular section of the ring the resisting moment will be $1/6\ ft^2$ where f is the unit-stress at the remotest fiber. In those sections where there is no thrust, the maximum stress (stress at the remotest fiber) may be found by equating the expression for the resisting moment and the expression for bending moment, and substituting the numerical values at the section considered. If a thrust exists at the given section, this thrust may be considered to be uniformly distributed over the section and the stress will be equal to the sum or difference of the resisting moment stress and the thrust stress.

For a concentrated load at the crown (Fig. 1) the

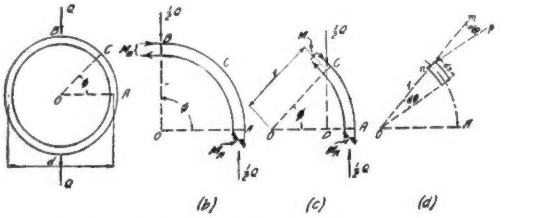


FIG. 1—RING UNDER CONCENTRATED LOAD.

stress at B, since there is here no thrust, may be determined from the formula

$$1/6\ ft^2 = M_B = 0.159\ Qd \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where Q is the concentrated load applied at the crown and d is the mean diameter of the ring. The maximum tensile stress and the maximum compressive stress at this section will be equal. As this is the section of greatest bending moment and as the tensile strength usually governs the strength of the rings under consideration, this equation is the one to be used in tests with a concentrated load.

At A the same form of expression may be used for the resisting moment, but this must be combined with the stress due to the vertical thrust, $\frac{1}{2}Q$. Considering this thrust to be uniformly distributed, the stress in the remotest fibers will be

$$f = \frac{1}{2}\frac{Q}{t} \pm \frac{M_A}{1/6\ t^2} = \frac{Q}{t} \pm \frac{0.091\ Qd}{1/6\ t^2} \quad \ldots (2)$$

The — sign will be used for the outer fiber and the + sign for the inner fiber.

At any point C (Fig. 1 (c)) the stress at the remotest fiber may be shown to be

$$f = \frac{1}{2}\frac{Q\cos\phi}{t} \pm \frac{M}{1/6\ t^2} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

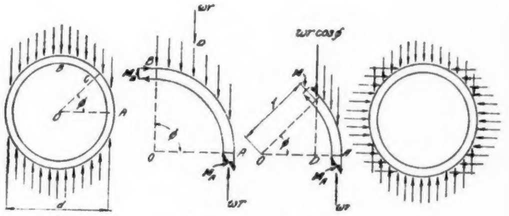


FIG. 2—RING UNDER DISTRIBUTED VERTICAL LOAD.

For a uniformly distributed horizontal load the stress at the crown B will be, calling W the total distributed load on a ring of unit length and d the mean diameter of the ring,

$$f = \frac{M_B}{1/6\ t^2} = 1/16\ \frac{Wd}{1/6\ t^2} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

and at A

$$f = \frac{1}{2}\frac{W}{t} \pm \frac{M_A}{1/6\ t^2} = \frac{1}{2}\frac{W}{t} - \frac{3}{8}\frac{Wd}{t^2} \quad \ldots (5)$$

and at any point C

$$f = \frac{wr\cos^2\phi}{t} \pm \frac{M}{1/6\ t^2} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

For rings in which tensile stresses control, the weakest section is at the crown, and equation (4) may be used.

For a distributed vertical and horizontal load (Fig. 3) there will be a thrust at both A and B. The stresses at the crown B will then be given by the following equation, calling q the ratio of the horizontal intensity of the load to the vertical intensity.

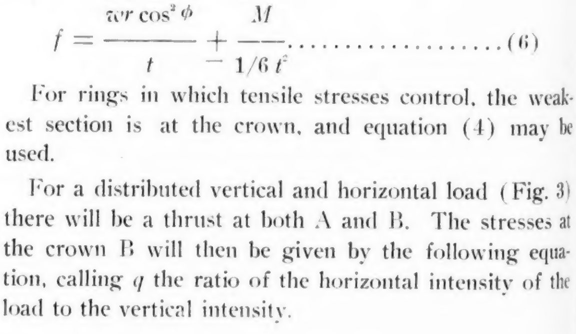


FIG. 3—RING UNDER DISTRIBUTED VERTICAL AND HORIZONTAL LOAD.

$$f = \frac{qwr}{t} \pm \frac{1/16\, Wd}{1/6t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

and at A the extremity of the horizontal diameter

$$f = \frac{wr}{t} \pm \frac{1/16\, Wd}{1/6t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

At any point C (Fig. 4) the expression for the stresses may be written

$$f = \frac{wr\cos^2\phi}{t} - \frac{qwr\sin^2\phi}{t} \pm \frac{M}{1/6\, t^2} \quad \ldots\ldots (9)$$

These formulas are directly applicable to homogeneous elastic rings in which the modulus of elasticity of the material remains constant. These conditions are not strictly true for rings made of cast iron or of concrete or reinforced concrete. However, they may be applied without any great error to cast-iron rings and plain concrete rings at the breaking loads, if the modulus of rupture of the materials obtained under the same condition of thickness and loading be substituted for the maximum tensile stress f.

For a ring made of reinforced concrete the conditions differ somewhat from the foregoing. For ordinary cases it will not be far from the truth to equate the bending moment determined as above and the resisting moment

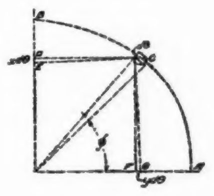


FIG. 4—DEFLECTION OF RINGS.

of the reinforced concrete section. As the amount of reinforcement is usually lower than that in which the circular beam would fail by compression in the concrete, we may, without material error, take for the resisting moment of the reinforced concrete section the value .87 Aft, where t is the distance from the compression face to the center of the steel reinforcement, A is the area of the cross-section of the reinforcement for a unit of length of ring, and f is the tensile unit-stress in the steel due to the bending movement. To equate the bending moment determined as before to this resisting moment is not exactly correct, since among other reasons the neutral axis does not come at the center of the thickness of the ring (which is the point about which the bending moments were taken), and since the elastic curve is not the same as in a ring of homogeneous material, and hence the distribution and amounts of the bending moments will not be exactly the same. However, the use of the bending moments determined for homogeneous rings is the nearest approximation we have, and is not seriously in error. At sections where thrust occurs, as at A, (Fig. 2), the tension in the steel determined as above will be reduced by the resisting compressive stresses there set up. The amount of the tension in the steel at the point A may be calculated by the formula

$$f^1 = f - \frac{\frac{1}{2}\, n\, T}{t\,(1+np)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

which is applicable for both concentrated and distributed loads. In this formula f is the tensile stress in the steel due to the bending moment (as calculated by equating .87 Aft to the bending moment at the section considered), p is the ratio of the area of reinforcement for a unit length of beam or ring to the distance between the center of the steel and the compression face of the concrete, T is the thrust or pressure against the face of the section, and n is the ratio of the moduli of elasticity of steel and concrete, which, for purposes of this calculation, may be taken as 15. At the extremity of the horizontal diameter the thrust is $\frac{1}{2}$ W. At the crown it is zero for vertical loading, and for both concentrated and distributed load the greatest tensile stress is found at this section.

GENERAL COMPARISON OF RESULTS.

Comparison of Methods of Loading.—The tests under concentrated load for both the cast-iron rings and the reinforced concrete ring gave results which are consistent with analysis, both as to strength of the rings and as to the nature of the deflection curves and the amount of the deflection. The cast-iron rings broke suddenly, but the reinforced concrete rings maintained the maximum load until the deflections had increased materially. It is evident that the reinforced concrete structure may be deflected much beyond the amount which is produced by the critical load before final failure results.

In the discussion of the tests under distributed load for both the cast-iron pipe and the reinforced concrete pipe, it was noted that the determination of the resistance of the pipe to distributed load is much complicated by the uncertainty in the distribution of the load and in the amount of lateral pressure which may be developed. It is worth while, however, to make a discussion of the observations and calculations to see what conclusions may be drawn. In Table 10 already referred to are given values of the bending moment and resisting moment developed in the cast-iron pipe, and in Table 16 values of these moments for the reinforced concrete pipe. As has already been noted, the expression used for the bending moment, 1/16 Wd, is based upon the assumption that the load is uniformly distributed over the horizontal section both longitudinally and transversely, and also that there is no lateral restraining pressure. The value of the resisting moment in Table 10 is based upon the modulus of rupture determined from the tests of the cast-iron rings under concentrated load. The value of the resisting moment of the reinforced concrete pipe in Table 16 is based upon the ordinary formula for strength of a reinforced concrete beam at the yield point of the reinforcement and does not consider that failure by diagonal shear or other cause may occur earlier.

Under the above assumptions the ratio of the resisting moment to the bending moment developed, as given in

the above table, should be unity. If a lateral pressure acts, the ratio should be less than unity and its value would correspond to the $1 - q$ of equation.

$$M_B = -M_A = 1/16\ (1\text{-}q)\ Wd$$

If the lateral pressure is 25% of the vertical pressure, both being assumed to be uniformly distributed, the ratio would be 0.75. If, however, the load is not uniformly distributed over the horizontal section the effect would be to give a larger ratio in the calculations made than would be found if the actual distribution of the load were known and used. The effect of the bell itself may possibly make the resisting moment of the pipe smaller than is assumed in the tables.

The average value of the ratio in the table for the cast-iron pipe is somewhat less than unity. It has been suggested that the higher values of this ratio may be due to uneven bending and distribution of the load and this is borne out by some of the observations of the test. The lower values of the ratio indicate the presence of considerable lateral pressure, and the effect of no lateral pressure upon deflections was quite apparent in the test of cast-iron pipe No. 990, and in the reinforced concrete ring No. 923, where the horizontal restraining rods were kept loosened.

Evidently there is more or less variation in the conditions of the test and probably also in the resisting strength of the pipe. In the reinforced concrete rings and pipe the selection of the critical load given in Table 16 is dependent somewhat upon judgment, but the values have been compared with the conditions in the concentrated load tests, and changes which may be made by different individuals would not affect the results materially. The value of the ratio of the two moments is seen to be quite similar to those given in the table for the cast-iron pipe, and its average is under unity. Evidently the conditions relating to the distribution of load and the effect of the lateral pressure are similar to those found in the test of cast-iron pipe. For high percentages of reinforcement or with steel of a high elastic limit, like drawn wire, the pipe is likely to fail by other forms of failure than through the steel being stressed beyond its yield point.

In the reinforced concrete pipe beyond the so-called critical load the action of the structure, as has already been stated, is quite different and the final failure is through crushing of the concrete. It would seem that this strength is available in an emergency, though the condition of the concrete in reference to cracks and defects may be such as to affect the durability of the structure.

Measure of Strength of Pipe.—From these tests it seems evident that the lateral restraint is considerable and that the pressure exerted at the sides aids considerably in holding the pipe from large deflections and thus strengthens it materially, but at the same time the apparent effect of this is largely counteracted by the lack of uniformity in the distribution of the load and the lateral pressure, which results in making the bending moment of the vertical load larger than the assumed moment. Any reduction in the ratio $1 - q$ below unity

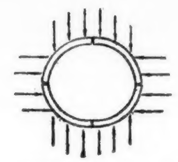


FIG. 5—ACTION OF UNREINFORCED PIPE UNDER DISTRIBUTED LOAD.

which may be found in the tests may be considered to be merely an added safeguard. It will probably be best then to use $1/16\ Wd$ for the bending moment coming upon such a pipe when the bedding and later filling are well done, considering any reduction in the ratio of moments here discussed only as a margin of safety. In case of careless or indifferent bedding or filling the lack of uniformity of distribution of pressure transversely and longitudinally will require that a higher bending moment than $1/16\ Wd$ be used.

The strength of cast-iron pipe may be calculated by using, in the expression for resisting moment, a value of the modolus of rupture, say 25% less than the modolus of rupture obtained by breaking small beam test specimens of the same metal. The effect of the presence of the bell is somewhat uncertain but it is quite probable that greater strength could be obtained by distributing the metal of the bell throughout the barrel of the pipe. It seems probable, too, that as ordinarily laid in the embankment the stiffness of the bell will interfere with the distribution of pressure over the bed and thus reduce the strength of the culvert. It should be noted, too, that it is probable that the quality of the cast-iron pipe tested was better than the ordinary run of cast-iron culvert pipe used by railroads. In the tests the cast-iron pipe failed at the maximum load and the load sustained dropped off suddenly, indicating that there would be a complete collapse under a dead load.

The critical strength of reinforced concrete culvert pipe where the reinforcement does not exceed, say 0.75 of 1% and is of medium steel may be measured by the resisting moment calculated by the ordinary beam formula. This, of course, is with good concrete. The resistance against diagonal tension and stripping of the concrete over the bars may be improved by flattening the arc around the top and bottom and possibly by the use of stirrups at these points. The actual load which the reinforced concrete pipe will take above this critical load is a great safeguard. The property which a reinforced concrete beam has of holding a load near its maximum

No.	W' Load at First Crack lb. per lin. ft.	W Breaking Load lb. per lin. ft.	M' $\frac{Wd}{16}$	M_0 $\frac{fbt^2}{6}$	Ratio $\frac{M_0}{M'}$
		Pipes			
990	26 700	37 500	115 000	85 600	0.74
991	22 600	26 400	81 000	102 000	1.26
992	16 300	22 600	69 000	92 300	1.34
993	54 600	54 600	169 000	102 000	0.60
994	47 300	49 300	152 000	134 000	0.88
995	19 300	22 200	52 000	57 800	1.11
996	37 300	37 300	87 000	110 000	1.26
997	25 200	27 300	63 000	38 200	0.61
998	29 300	37 200	86 000	93 400	1.08
		Rings			
992A	22 150	22 150	68 000	92 500	1.36
993A	29 250	29 250	90 000	104 000	1.16

TABLE 10—CAST IRON PIPE AND RINGS—DISTRIBUTED LOAD.

No.	Load at First Crack lb. per lin. ft.	Resisting Moment *$\frac{1}{6} fbt^2$	$\frac{1}{16} Wd$	Ratio	Maximum Load lb. per lin. ft.	Remarks
903	3 550	17 640	12 000	0.68	30 500	Load still going up. Test discontinued.
906	4 800	17 640	16 200	0.92	44 000	
985 & 986	2 000	12 250	6 630	0.54	40 000	Pipes from Jackson, Michigan.

* Assume $f = 245$.

TABLE 16—CONCRETE RINGS AND PIPE, DISTRIBUTED LOAD.

load through a considerable deflection may be of great value in case the earth at the sides yields and the pipe must follow it to get the benefit of side restraint.

Loads and Failures.—The distributed load tests herein described were made with the filling of sand carefully placed and packed. It is evident that the condition of the bedding and filling and also the nature of the materials used in filling over the pipe will have a great influence upon the amount of the load and upon its distribution. The experience in the breaking of vitrified pipe sewers is analogous. Many cases of breakage of lines of pipe sewer have been reported in diameters from 18 in. upward. These instances have occurred in rock and clay more generally, though such failures are found in sand and quick-sand. The load which will come upon such sewer pipe from the trenches will vary with the manner of filling and the nature of the soil, as has already been suggested. Failures of cast-iron pipe under high embankments have been reported. In some of these cases the loose rock which was used for filling produced high loads. The effect of the manner of filling and of the nature of the material and the cause and prevention of such breakages would make a long paper by themselves. It is hoped, however, that the publication of this paper will bring to light instances of the failure of culvert pipe and sufficient data to throw light upon the loads which were produced by the embankment. If engineers will report the circumstances attending such failures, the height of the embankment, the conditions of the bedding, the nature of filling, the nature of the materials placed in the filling, and the time which had elapsed after construction, the information will be very helpful in planning new structures, particularly where new types of construction like concrete and reinforced concrete are to be used. Such data will add much to the information given in this paper.

Summary.—From the tests and the discussions it would seem evident that among the facts brought out are the following:

1. The cast-iron rings broke under a concentrated load at a calculated modulus of rupture 25% less than the modolus obtained from rectangular test pieces cut from the rings. The average value of the modulus of rupture for the ring tests was 27,000 lbs. per sq. in., and it should be noted that this value was obtained with an excellent quality of iron.

2. The cast-iron pipe loaded in sand broke suddenly at one end or the other, finally breaking through the entire length of the pipe. Upon failure the load dropped materially and there was little further strength to the structure. The stiffness of the bell affected the deflections and acted to prevent a uniform distribution of stress throughout the length of the barrel. The presence of the bell adds to the difficulties of securing a uniform distribution of the load, and detracts from the strength of the pipe.

3. The plain concrete rings broke under slight deflections at loads which agreed well with the calculated strength, both under concentrated load and distributed load. In the testing box under the restraining lateral pressure these rings held high loads after the segments had been deflected considerably from their original position, finally breaking by crushing of the concrete under conditions shown in Fig. 5.

4. The reinforced concrete rings in the concentrated load tests held their maximum loads or about their maximum loads through a considerable deflection, thus showing a quality which is of value when changes in earth conditions permit a gradual yielding of the surrounding earth. The calculated restraining moment agrees fairly well with the calculated bending moment.

5. The reinforced concrete rings and pipes tested under distributed load made a satisfactory showing. The so-called critical failure may occur by either tension failure in the steel or a diagonal tension failure (ordinarily called shearing failures) in the concrete. A flattened arc for the reinforcement where it approaches the inner face is of assistance and stirrups may be of some value. Beyond the critical load the reinforcement is of service in distributing the cracks and in holding the concrete together. Final failure is by crushing of the concrete in much the same way as was obtained with the plain concrete rings. The additional strength beyond the critical load may be taken into consideration in selecting the factor of safety or working strength.

6. The restraint of the sand in the tests is very important, and the effect is to reduce the bending moment developed by a given vertical load, or, as it would be commonly stated, to add strength to the pipe. The degree of permanency of this side restraint is uncertain. It seems evident in these tests that the distribution of the pressure, both horizontal and vertical, was not uniform, and that with the usual method of placing a pipe in an embankment, and especially when other materials than sand are used, the distribution would be even less uniform than here found. In view of this it will be well in making calculations and designs to use the formula 1/16 *Wd* for the bending moment, thus considering that the side of restraint is offset by the uneven distribution of

the load, any surplus from this being considered merely an additional margin of safety. For pipes poorly bedded and filled a larger bending moment than 1/16 *Wd* should be used.

7. The method of bedding and laying pipes and the nature of the bed and the surrounding earth have a great effect upon the bending moment developed and upon the resistance of the pipe to failure. If the method of laying or the hardness of the soil below, or the condition of the settlement of the pipe is such that the pipe is supported only or mainly along an element of the cylinder at the bottom the bending moment developed will be greatly increased over that of a uniformly distributed support. If the greatest supported pressure comes at points well to the side of this bottom element, as may be obtained by careful bedding, the bending moment is reduced. It is also plain that the bell should be left free from pressure at the bottom. It is possible that the presence of the bell detracts from the strength of the pipe. Any action in filling which increases the lateral restraint against the pipe will add to the security of the structure.

Released Rates

THE Interstate Commerce Commission reported at a recent meeting on the matter of released rates. After a careful consideration of the legal problems involved the following conclusions were reached by the Commission:

I. If a rate is conditioned upon the shipper's assuming the risk of loss due to causes beyond the carrier's control, the condition is valid.

II. If a rate is conditioned upon the shipper's assuming the entire risk of loss, the condition is void as against loss due to the carrier's negligence or other misconduct.

III. If a rate is conditioned upon the shipper's agreeing that the carrier's liability shall not exceed a certain specified value—

(a) The stipulation is valid when loss occurs through causes beyond the carrier's control.

(b) The stipulation is valid, even when loss is due to the carrier's negligence, if the shipper has himself declared the value, expressly or by implication, the carrier accepting the same in good faith as the real value, and the rate of freight being fixed in accordance therewith.

(c) The stipulation is void as against loss due to the carrier's negligence or other misconduct if the specified amount does not purport to be an agreed valuation, but has been fixed arbitrarily by the carrier without reference to the real value.

(d) The stipulation is void as against loss due to the carrier's negligence or other misconduct if the specified amount, while purporting to be an agreed valuation, is in fact purely fictitious and represents an attempt to limit the carrier's liability to an arbitrary amount.

In the above it is plainly indicated that the carrier is liable for any loss due to the carrier's negligence or other misconduct, but that agreements concerning causes beyond the carrier's control are valid. The stipulations as to the value of goods are dependent upon the conditions of acceptance.

Play between Rail and Fishplate

A METHOD of preventing play between rail and fishplate is indicated in an article by Leon Edelstein in the Bulletin of the International Railway Congress Association. Extracts from the article are as follows:

Experience has shown that the fishplates and the ends of the rail-heads become affected and worn at the rail-joints, in course of time, by the effect of the vertical pressure which the wheel exercises first on the one and then on the other rail-head end.

Wear is shown more especially at the upper surface of the fishplate, in the middle, and at the lower surfaces of contact of the rail ends, so that play results at these points; the actual rail ends become depressed and the joint loses its original stiffness (Fig. 1). Owing to the fact that the rail ends have lost their support, the rolling stock suffers severe shocks at the fishjoints, which are not only uncomfortable to the passengers but also accelerate the wearing of the rails and fishplates. Rails and fishplates become useless in a comparatively short time and have to be replaced.

Trials made on several experimental sections have proved the new steel packing pieces with inserted strips (Austrian patent No. 27798 of 1907, Edelstein's system) of steel satisfy all requirements. The packing piece consists of a piece of sheet steel, which has its edge folded over so as to form a narrow channel into which steel strips of different length are inserted. This makes it possible to give the packing the shape required in order to fill as uniformly as possible the spaces produced by wear and to make the rail joint stiff.

The packing is made of sheet steel 1 millimetre (0.04 in.) thick. The upper part *a* (Fig. 2) is for folding over, so as to hold the inserted strips *b* and *c*, which are also 1 millimetre (0.04 in.) thick.

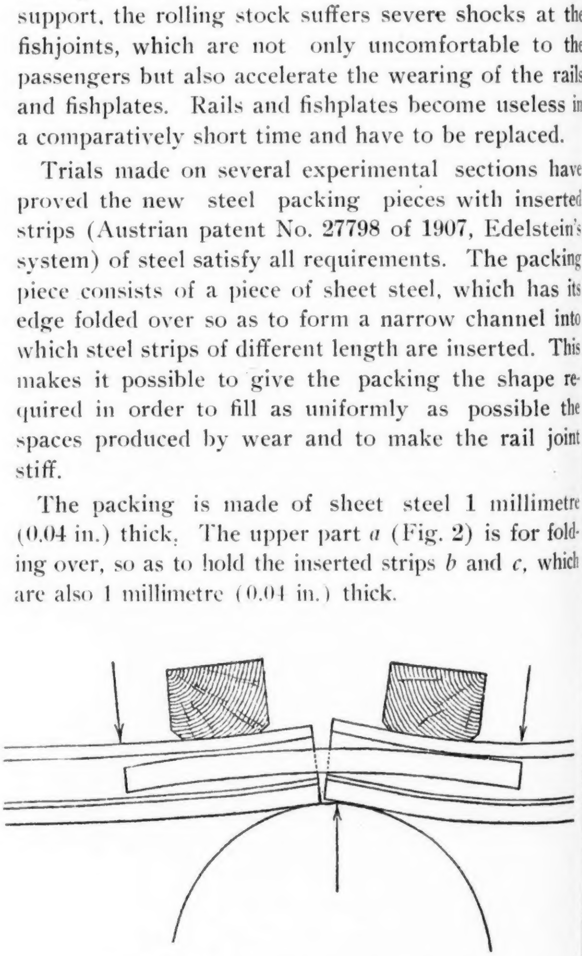


FIG. 1—PLAY BETWEEN RAIL AND FISHPLATE.

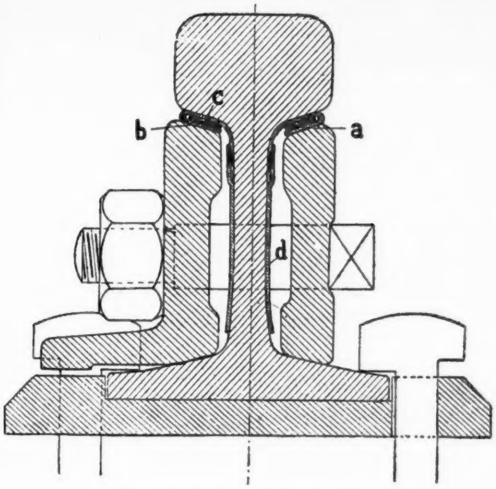


FIG. 2—SHOWING NEW STEEL PACKING.

The strips *b* and *c* are shorter than the whole packing and are also unequal in length. Similarly, the folded over portion is longer than the longer inserted strip and shorter than the whole packing, so that the packing when completed tapers from the middle to the ends, being thickest at the middle where there is most wear. The channel containing the inserted strips is bent at an obtuse angle so as to fit the underside of the rail-head. The packing has riveted on to it, at the middle, a 1 millimetre (0.04 in.) thick strip of iron *d*, forming a support which makes it easy to place the packing in the correct position when introducing it between the fishplate and the rail. The support is riveted on, for convenience of manufacture, saving material; it must not be wider or thicker, or else it would produce resistance, on sections which creep, which would be very injurious to the packing. By taking inserted strips of varying number and varying thickness (1 to 2 millimetres [0.04 to 0.08 in.], the curvature or taper of the packing can be adapted to the requirements of practice, to the wear observed. As already observed, the way the packing is folded retains the strips and makes it impossible for them to be forced out; consequently, the chief condition of a suitable packing is satisfied. If a rail-joint which has become defective through wear is to be made good again, the fishplate is taken off, a packing piece corresponding to the wear is put into place and the fishplate immediately secured again. Experience has shown that a thickness of 3 to 4 millimetres (0.12 to 0.16 in.) is most suitable for such packing pieces.

The Pan-American Railway may be extended to connect the United States and Panama. The road now extends from San Jeronimo on the Tehuantepec Railway to Tapachula in Chiapas. Mr. J. M. Neeland, vice-president and general manager, is quoted as saying that work would be continued actively until connection is made with the Guatemala railway.

The New Orleans Passenger Terminal

THE new passenger station of the New Orleans Terminal Company is located on the northeast side of Canal street, occupying the right-of-way of the old street car line and taking up a width of 82 ft. at the center of the old Basin avenue and leaving an open street on each side 45 ft. in width. Facing as it does on Canal street, directly opposite the prolongation of Basin avenue, the station fronts on an open area of unusual size and is, therefore, especially well located as regards suitable setting.

The head house, or station building proper, is 82 ft. in width and 230 ft. in depth. The style of architecture is a sober treatment of the modern French. Recognizing the fact that a railroad station is intended to handle large crowds of people, the aim of the design is to convey the impression of openness and to this end the main front is treated with a single archway flanked by a treatment of coupled columns and crowned by a high attic carrying an inscription.

The main entrance archway is about 30 ft. in width and 40 ft. in height. This archway opens directly into the waiting room which is a room 80 ft. long and 40 ft. wide and is 52 ft. high to the soffit of the central dome. The waiting room also opens out to the right and left directly to the two side streets through other archways about 30 ft. high. The main motive of the building is, therefore, that of a large vestibule which can be freely entered on all sides, the side entrances being provided with Marquise for the convenience of passengers arriving at the station in carriages or motor cars.

The main waiting room extends onward toward the tracks through a lobby 28 ft. wide and 130 ft. long. Around this waiting room and its extension—the lobby—are grouped the usual services consisting of ticket office, telegraph office, flower stand, news stand, large waiting room for women with retiring room, smoking room for men, baggage room and lunch room. The colored waiting room is located on the side street with a separate entrance.

The scheme of treatment of the waiting room is a masonry effect consisting of marble up to a height of 12 ft. from the floor, the remainder being done in cement in imitation of stone of a light color to go with the marble.

The four tracks of the passenger terminal stop against a concourse 80 ft. long and 35 ft. wide which is provided with independent exits at both ends so that the passengers arriving on trains can make their way immediately to the street through either entrance without conflicting with the current of passengers about to take trains.

As regards materials, the exterior lower portion of the main building next Canal street is granite and the upper portion Bedford stone. The remainder of the building is a combination of brick and stone, the

brick being a special gray brick selected to match the Bedford stone.

The basement is provided with the usual heating plant and the second story contains complete suites of offices, each with outside light and all being arranged around the central corridor facing inside light court.

There will be no large train shed. For a number of years the idea has been gaining ground among railroad men that the large train shed does not justify its very high cost. Once built, the cost of maintenance is so large as to make it practically impossible to keep it clean and well lighted. Owing to the large expansion and contraction it is also difficult to keep raintight with the result that there is constant leaking of water, dirt and grease. In the very large sheds, one sometimes sees almost an interior rain storm due to condensation, when the weather is perfectly clear outside. As in the case of the Washington Terminal where the climate is mild, the low shelter shed seems to present the most satisfactory arrangement and has been adopted. The shed is of the French type with roofs sloping upward from the central gutter.

In the New Orleans shed a great deal of thought has been given to studying out a satisfactory way of handling the down-spout so that the whole will present a neat and clean appearance, the down-spout in this case being carried through the center of the cast iron column carrying the shed. This cast iron column is provided with an Ionic cap in sympathy with the architectural treatment of the rest of the building. The length of the train sheds is 720 ft. and in order to obstruct the platform as little as possible the train shed columns are spaced 30 ft. from center to center.

The building stands on a pile foundation such as is used for most of the buildings in New Orleans, which was worked out with a special object of adaptation to the old drainage canal which runs beneath the center of the building.

The frame work in the large main waiting room in the Canal street end is of steel carrying stone and concrete roofs and dome. The remainder of the building is of masonry construction.

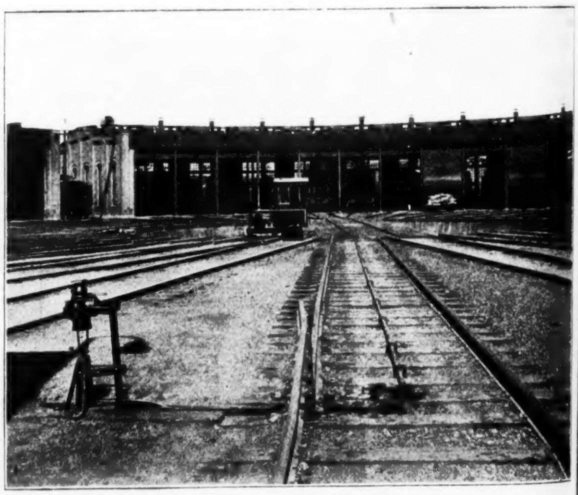
The cost of the building and train sheds, exclusive of all track work and interlocking is about $250,000. The plans were worked up under the direction of Captain Hinckley, chief engineer, Frisco System, and the construction carried out under his direction. The architects are D. H. Burnham & Co., of Chicago, and the contractor, James Stewart & Co., of St. Louis and New York. The station was opened for passenger traffic about June 1, 1908.

Derail for Turntable

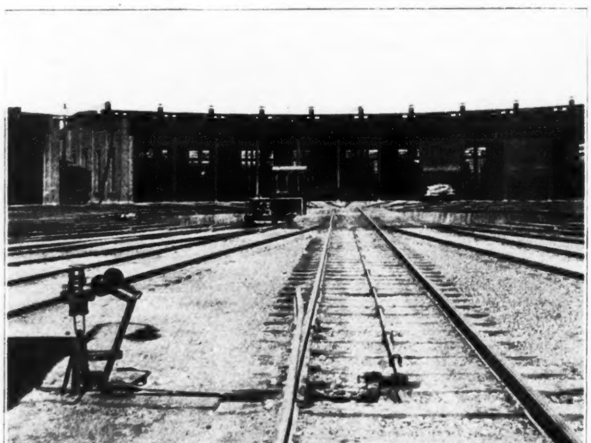
IN the accompanying illustrations a derail is shown both in the open and closed positions. The device consists of a split switch point at a distance of 30 to 75 ft. from the turntable, the distance depending on conditions. The point is operated by the solid connecting rod in the center of track back to the turntable.

The point is held open by a heavy coil spring and is closed by the turntable itself when the roller contact on the turntable strikes the bearing in center of track connected with the switch point. The switch point is then forced against the stock rail. As the table moves out of line of the track, the switch point opens.

This device is known as the Ogle Turntable Derailer. It makes it impossible for an engine or car to be run into the turntable pit as it is a positive derail until the turntable is lined up for the track when the derail is automatically closed. When the table is moved out of line even slightly, the derail is open, making every track leading to the turntable inoperative. This derail prevents the running of engine or cars into the turntable pit, which might tie up every engine in the roundhouse for a long time.



DERAIL FOR TURNTABLE IN OPEN POSITION.



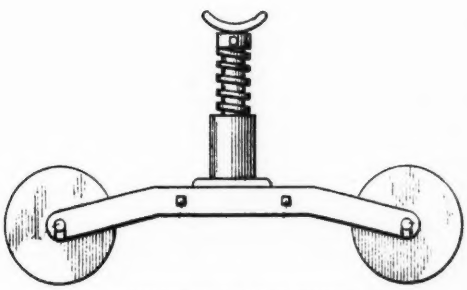
DERAIL FOR TURNTABLE IN CLOSED POSITION.

Combined Jack and Truck

THE combined jack and truck consists of a pair of rollers, a platform secured between the rollers and a jack mounted on the platform. It is simple, strong and durable in construction and at the same time light in weight.

In removing and replacing car wheels the device may be used in any position. It is usually placed, however, in a pit under the car.

By jacking up the car sufficiently, the weight is removed from the car truck and the wheels may be taken from under the car. The jack and truck are placed at the end of arch bars, and when the wheels are rolled out they come directly over the jack in the truck. A plank is placed under the truck.



COMBINED JACK AND TRUCK.

When the wheels are jacked up, they can be turned in any position to facilitate removal and replacement and pulled out from under the car.

The best evidence of the advantage of this device is the fact that a roundhouse foreman borrowed the jack and truck from the repair gang in order to replace the inside wheels under a tender. The device was invented and patented by Oscar F. Sandberg, Willmar, Minn.

Cab Signals in Germany

THE over-running of signals at danger in Germany, particularly in foggy weather, has brought forward the question, as in the United Kingdom, of transmitting signals to the cab of the locomotive itself. But while the British schemes in general aim at the reproduction in miniature on the cab of the actual position of the semaphores arranged along the railway ahead, it would appear that the Teutonic idea is merely to show to the driver, by means of an apparatus in front of him, that he must expect to reach a signal in less than a distance of 100 meters in advance, and that he should, therefore, take precautions to proceed to the signal post for the definite instruction. The reason for the German abstention from intimating to the driver on the cab the exact position of the signals is said to lie in the belief that if he had no signals to observe outside his cab the attention which he should devote to the track would considerably diminish. It is also held that the look-out from the locomotive, which is unconditionally necessary for the safety of the train, would gradually be abandoned altogether, and observations would only be made of the indications given by the small apparatus on the locomotive. However this may be, the new signaling apparatus, which is coming into use on several railways, only aims at drawing the driver's attention by a visual signal on the cab to the fact that a signal will be met in a very short space of time. The system consists in the installation at a definite distance from each ordinary track signal of two parallel iron bars several meters in length, having a slight space between them and laid near the track. From the locomotive projects an arm which carries a brush formed of flexible copper wires, and the brush is led through the space between the bars while passing them. This operation completes an electric circuit on the cab and causes a bell to ring and a red disk to be substituted for a white one. The acoustic and visual signals remain in action until the driver, by pressing a button, disconnects the circuit. It is stated that the contact between the copper wire brush and the bars fixed near the track is entirely free from shock, the flexible arrangement having accomplished what was impossible with rigid contact pieces. It has, in fact, been found by experiments that no rigid contacts are able to withstand the impact, especially at high railway speeds.—Electrical Review (London.)

Railroads and Wood Preservation

THE recent action by the board of directors of the American Railway Engineering and Maintenance of Way Association in appointing a committtee of seventeen to investigate and report upon the subject of wood preservation has shown that the practical railroad men of the country recognize the importance of taking steps to conserve the rapidly diminishing timber supply of the United States.

Timber is one of the principal materials purchased by the railroads and its economical use is a subject of far-reaching importance. More than 100,000,000 cross ties are used annually by the different railroad companies, and their average life in this country is not more than six or seven years. From a study of European methods, and the knowledge of wood preservation under conditions in this country, timber testing engineers say it is reasonably certain that an average life of from 15 to 20 years may be secured by treating the tie with a good preservative and the use of improved devices for the prevention of mechanical abrasion, thus to a large degree diminishing the drain upon the timber supply.

While the quantity of timber used for ties is very great and the problem of a future supply is a serious one, yet this class of timber is not the only one which should receive consideration. A greater length of service from timber now used by railroads for bridges, trestles, piles, fences and transmission poles is greatly to be desired.

Prices on Track Materials, F. O. B. Chicago

Steel rail, 60 lbs. and over........$28.00 per gross ton
Steel rail, 25 to 45 lbs............. 28.00 per gross ton
Steel rail, 20 lbs.................. 29.00 per gross ton
Steel rail, 16 lbs.................. 30.00 per gross ton
Steel rail, 12 lbs.................. 31.00 per gross ton
Ties, 6x8x8 oak, 1st grade..................74c each
Ties, 6x8x8 oak, 2d grade...................67c each

Angle bars, accompanying rail orders, 1908 delivery, 1.50c.; car lots, 1.60c.; spikes, 1.80c. to 1.90c., according to delivery; track bolts, 2.20c. to 2.25c., base, square nuts, and 2.35c. to 2.40c., base, hexagon nuts. The store prices on track supplies range from 0.15c. to 0.20c. above mill prices. Switch set per turn out, 60-lb. rail, $85 to $90.

OLD METAL.

Old steel rails, rerolling..............$14.25 to $14.75
Old steel rails, less than 3 ft........... 12.50 to 13.00
Old iron rails....................... 15.50 to 16.00

SHEET STEEL.

It is quoted for future delivery:

Tank plate ¼-in. and heavier, wider than 6¼ and up to 100 ins. wide, inclusive, car lots, Chicago, 1.88c. to 2.08c.; 3/16 in., 1.98c. to 2.18c.; Nos. 7 and 8 gauge, 1.93c. to 2.13c.; No 9, 2.03c. to 2.23c. Flange quality, in widths up to 100 in., 1.88c. to 1.98c., base for ¼-in., and heavier, with the same advance for lighter weights; sketch-plates, tank quality, 1.88c. to 2.08c; flange quality, 1.98c. Store prices on plates are as follows: Tank plate, ¼-in. and heavier, up to 72 in. wide, 2.08c. to 2.10c.; from 72 to 96 ins. wide, 2.10c. to 2.20c; 3/16 in. up to 60 in. wide, 2.10c. to 2.25c.; 72 ins wide, 2.30c. to 2.40c.; No. 8 up to 60 ins. wide, 2.10c to 2.15c ; flange and head quality, 0.25c. extra.

STRUCTURAL STEEL SHAPES.

Store quotations are at 1.95c. to 2.00c., and mill prices are as follows: Beams and channels, 3 to 15 ins., inclusive, 1.78c.; angles, 3 to 6 ins., ¼-in. and heavier, 1.78c.; larger than 6 ins. on one or both legs, 1.88c.; beams, larger than 15 ins., 1.88c.; zees, 3 ins. and over, 1.78c.; tees, 3 ins. and over, 1.83c., in addition to the usual extras for cutting to extra lengths, punching, coping, bending and other shop work.

CAST IRON PIPE.

Quotations per net ton on water pipe, 4 ins., $27; 6 to 12 ins., $26; over 16 ins., $25; with $1 per ton extra for gas pipe.

CEMENT.

Good grade Portland cement, car lots....$1.65 per bbl.*

*(Four sacks per bbl. credited 10c each when returned in good condition.)

SAND.

Bank sand, car lot.......................$0.75 per yd.
Torpedo sand, car lot.................... 1.15 per yd.

CRUSHED STONE GRAVEL.

Crushed limestone, car lot...............$1.05 per yd.
Crushed gravel, car lot.................. 1.00 per yd.

Bolivian Railways

THE railroad situation in Bolivia is described in a report to U. S. Department of Commerce and Labor by Special Agent Charles M. Pepper. His report is in part as follows:

LINE FROM VIACHA TO ORURO.

The line from Viacha to Oruro is 125 miles in length. The total cost of this Oruro-Viacha section, including rolling stock, shop equipments, terminal facilities, engineering, and office expenses, will be approximately $4,000,000, or $32,000 per mile. It is not to be assumed, however, that the proposed network of Bolivian railways can be built and equipped at an average of $32,000 per mile. The central plain across which the Oruro-Viacha line runs is far from presenting a billiard-table surface. It is very broken, has some heavy grades, and requires a good deal of bridging and "viaducting" for protection against the rainy season. But it is of easy construction compared with the sections which are to be built in order to provide transportation facilities for the Potosi and other mineral districts, and its average cost per mile does not afford a safe basis of computation.

THE POTOSI SECTION.

Concerning the Potosi section there is an unsettled question. If the line is laid in conformity with the original plans, part of it will parallel the Antofagasta-Oruro Railway between Myuni and Oruro, the distance between these two points being 195 miles. The Antofagasta line, whose total extension from the coast to its terminal point at Oruro is 575 miles, is, in proportion to its length, the most profitable railroad on the west coast of South America. It is operated by an English company, though some shares are held in Chile. The Bolivian Government guaranteed 5 per cent on $3,750,000, which was the capital estimated to have been employed in building the Bolivion section of 300 miles, but the traffic has been so profitable that the payment of the guaranty never has been necessary. Notwithstanding the profits, the company has done little for the development of Bolivia since it failed to exercise the rights claimed for building extensions and to provide sufficient transportation facilities for the territory which it should have served.

The pending question is whether the Bolivian Railway Company, which is the American syndicate, and the Antofagasta company will come to some kind of a traffic arrangement for the operation of the Oruro Myuni section of the Antofagasta line or whether the parallel road shall be built. One hindrance to an agreement is the gauge of the Antofagasta road, which is 2½ feet, while that of the Bolivian railway is 3 feet 3⅜ inches, or 1 meter. The American capitalists would have preferred the standard gauge of 4 feet 8½ inches, but the preference of the Bolivian Government and the lower initial cost caused the meter gauge to be adopted. There is no probability, however, that the Americans will consent to take a step so far backward in railway construction as to incorporate a 2½-foot gauge into any part of their sys-

tem. The Antofagasta company, on its part, has a positive objection to the transshipment at Myuni, which will be necessary if the gauge be changed. The shipments from the Huanchocho mines, near Myuni, which are in Bolivian territory, and from the Chilean nitrate fields, which lie convenient to the coast, would be continued over the very narrow gauge section, but the products of the Oruro mining district, which might be shipped out by the Antofagasta line, and the general merchandise imported would have to be transshipped at Myuni.

It would be to the advantage of the Antofagasta company if the Viacha-Oruro line were not built at all, since this will divert some traffic by way of Lake Titicaca and Mollendo and later by the more direct route of Arica, but since the London company has not been able to prevent the construction of this railway, and will not be able to hinder more than temporarily the construction of further lines, the practical question is how best to adopt itself to the circumstances. In case the Bolivian Railway Company and the Antofagasta company fail to come to an agreement an extreme measure suggested is that the Bolivian Government expropriate the Myuni-Oruro section of the Antofagasta line.

London directors of South American corporations have not heretofore shown much disposition to accommodate themselves to new developments, particularly where their properties are earning satisfactory dividends without outlay for betterments or changes in the gauge and new equipment. This may account for the doubts felt in Bolivia about an agreement being reached which will insure harmonious instead of competing and combative railway construction.

American Railroad Ties in Honduras

A RAILROAD in Honduras which has just been opened to traffic as far as Ceiba, 35 miles, was built with creosoted pine ties from the United States.

The increased value of wood thus preserved is now well recognized by railroad men. The life of a railroad tie may be greatly lengthened and sometimes more than doubled by preservative treatment. In a humid climate like that of Honduras, a pine tie in its natural state would be quickly destroyed by fungus.

Large railroads of the United States treat with preservatives many, or all, of the new ties put in. One road is said to treat 10,000 a day. The increasing difficulty of procuring new ties, with the advancing prices, compels railroads to make them last as long as possible. It has been estimated that the railroads of the United States demand in a single year the ties growing on a forest strip one mile wide and three thousand miles long.

It is worthy of note that while creosoted pine ties are being shipped from the United States to Honduras, hardwoods are coming to the United States from that country. Americans are doing the shipping both ways. A tract of 8,000 acres in Honduras has been secured by an American company which will cut the mahogany and other valuable hardwoods and ship them to the United States.

New Roof of Charing Cross Station

The roof of the Charing Cross Station of the South Eastern & Chatham Railway, part of which collapsed about two years ago, is being rebuilt entire on a new plan. The old roof had arched trusses of 166 ft. span, spaced 35 ft. apart. The new roof is of the "ridge and furrow" type with spans less than 40 ft. The difficulties of inspection and painting were the chief reasons for changing from a single clear-span to bay construction. The bays run transverse to the tracks, or from wall to wall, and the trusses rest upon continuous lattice girders running from wall to wall. Each girder is supported intermediate of the walls by two steel columns. The distance between the west wall and the first column is 46 ft. 4½ in., between the two columns 54 ft. 3½ in., and between the column and the east wall 63 ft. 4¾ in. Practically the whole of the roof is glazed, the only exception being the jack roofs of the transverse bays. These are covered with uralite on close boarding. At first it was thought by some people that the temperature under this glass roof might prove excessive on a hot day, but experiments made during last summer show that the ventilation provided is quite sufficient.

Personals

C. H. Spencer has been appointed engineer of the Washington (D. C.) Terminal Company, with office at Washington, D. C., succeeding A. C. Shand.

W. F. Purdy has been appointed Chief Engineer of the Wabash Pittsburgh Terminal, in charge of construction and maintenance, succeeding H. T. Douglas, Jr.

R. A. Bainbridge, Assistant Division Engineer of the Canadian Pacific at Vancouver, B. C., has been appointed Division Engineer of the Esquimalt & Nanaimo, in charge of construction and maintenance, with headquarters at Victoria, B. C.

Hans Holland, formerly Engineer of Maintenance of Way of the Houston & Texas Central, and more recently in private business, has been appointed Superintendent of Maintenance of Way of the San Antonio & Arkansas Pass, with headquarters at Yoakum, Tex.

R. G. Kenly has been appointed Engineer Maintenance of Way of the Lehigh Valley, with office at South Bethlehem, Pa.

H. W. Crawford has been appointed Superintendent of Terminals of the Southern Pacific at Galveston, Tex.

G. P. Williams has been appointed Superintendent of Terminals of the Texarkana & Fort Smith at Port Arthur, Texas.

A. G. Faber has been appointed Signal Engineer of the Chicago, Rock Island & Pacific.

Mr. I. E. Matthews, engineer of maintenance of way of the Rochester Railway Co., has resigned and Mr. B. E. Tilton has been appointed to succeed him.

Trade Notes

The Veteran Association of the Nickel Plate Railroad was organized in 1907 and on October 23d of that year, which marked the twenty-fifth anniversary of the opening of the N. Y. C. & St. L. R. R. for business, a body of employees of the railroad, who had entered the service on or before Oct. 23, 1882, held their first regular meeting. The preamble to the constitution of the association reads as follows:

"A number of persons, having on October 23d, 1907, completed twenty-five years of service in various capacities on the New York, Chicago & St. Louis Railroad, and being desirous of forming an organization, to foster social feeling, to create and maintain mutual interest in the common welfare, and to diffuse knowledge of railway science and administration, do hereby associate themselves together, and have adopted the following constitution."

The official proceedings of the association have recently been published in printed form.

Edward & Zook, consulting and civil engineers, 50 Church street, New York, have completed the physical and real estate valuation of the New York, New Haven & Hartford for John F. Stevens, and are now prepared to engage in railroad surveys, location, construction, reconstruction, examinations, estimates, valuations, reports and superintendence.

G. E. Ellis, signal engineer of the Chicago, Rock Island & Pacific, has gone to the Federal Signal Co., Albany, N. Y., as manager of installation.

Technical Publications

VOIDS, SETTLEMENT AND WEIGHT OF CRUSHED STONE, by Ira O. Baker. Published as Bulletin No. 23 by the University of Illinois, Engineering Experiment Station, Urbana, Ill. Copies may be obtained gratis from the Director, L. P. Breckenridge.

This bulletin gives the results of some experiments to determine the proportion of voids in crushed stone loaded by various methods in cars and in wagons, to find the amount of settlement during transportation in wagons and in cars, and also to obtain the relation between the weight of a unit of volume of the solid stone and that of the same volume of crushed stone immediately after being loaded in various ways, into cars and wagons, and also after being transported different distances. Crushed stone is usually nominally bought and sold by volume but really by weight, since in ordinary commercial transactions the weight of a cubic yard of crushed stone is assumed and the number of yards in a shipment is obtained by dividing the total weight by the assumed weight of a cubic yard; and yet there seem to have been almost no experiments made to determine the actual weight of a cubic yard of crushed stone under any particular condition. Apparently the only experiments heretofore made upon this general subject are a few brief ones upon trap rock, conducted by Mr. McClintock, lately president of the Massachusetts Highway Commission. An account of his experiments is presented and discussed in this bulletin, but the main features are an elaborate series of tests upon crushed limestone from Chester, Joliet and Kankakee, all in Illinois. All the results are summarized in a table which gives for different sizes of crushed stone the coefficients by which to multiply either the weight of a cubic foot of the solid stone (or its specific gravity) to get the weight of a cubic yard of the crushed stone at the crusher and also at the destination, for stone from the three different quarries. This elaborate table is summarized in the following staement: The mean coefficient by which to multiply the weight of a cubic foot of solid limestone to obtain the weight of a cubic yard of crushed limestone is as follows:

For ½-in. screenings....................15.5
For ½-in. to 2-in. stone..................14.6
For 2-in. to 3-in. stone..................15.2

For trap rock the corresponding coefficients are as follows:

For ½-in. screenings....................14.6
For ½-in. to 1½-in. stone...............13.5
For 1½-in. to 5-in. stone................13.9

ARCHITECTS' AND BUILDERS' POCKET-BOOK, by Frank E. Kidder. Published by John Wiley & Sons, New York. Leather binding, 1,661 pages, 4x6½ ins., illustrated. Price, $5.00.

The fifteenth edition of this useful handbook for architects, structural engineers, builders, contractors and draftsmen, and valuable book of references for everything relating to construction and equipment of building, has been revised and brought up to date. The changes in this edition consist of the correction of all typographical errors reported to the publishers, and the rewriting of Chapters XXIII and XXIV. This work has been done by Rudolph P. Miller, who was for ten years connected with the Department of Buildings, New York City, and for the last five years as its chief engineer. During his connection with the Department of Building he had large opportunities for studying fireproof construction particularly, and gave the subject of reinforced concrete much study, drafting the first regulations ever promulgated in this country regarding its use. These regulations have formed the basis of the regulations since adopted by the cities of this country, in many instances the major part of them being copied verbatim.

Chapter XXIII has been revised, one-half of the matter in the old edition having been used again. The new matter has been substituted for such parts as have been found necessary or out of date.

Chapter XXIV, on Reinforced Concrete, is entirely new, the whole manuscript being original and Mr. Miller's own work.

Professor Alvah H. Sabin has brought the section on Paints and Varnishes up to date.

THE PRINCIPLES OF MECHANICS, by Henry Crew, Ph.D. Published by Longmans, Green & Co., New York. Cloth binding, 295 pages, 5x8 ins., illustrated.

The book is published for students of physics and engineering and represents a lecture course in physics at Northwestern University. The chapter headings are as follows: Kineomatics, Kinetics, Some Application of General Principles to Special Problems, Friction, Dynamics of Elastic Bodies and Fluid Motion.

The basic principles of this volume, as given by the author, are as follows:

"First, to lead the student to clear dynamical views in the shortest possible time, without sacrificing him upon the altar of logic, yet pursuing a route which he can afterwards follow with safety.

"Second, to build the discussion upon a few simple experiments and upon definitions which convey at once the physical meaning of the quantities defined. Thus, torque is introduced, not as the vector product of force and distance, but as the time rate of variation of angular momentum.

"Third, to follow the example of Föppl in using vector analysis merely to permit a clear, simple, and accurate picture of the facts, reserving the cartesian analysis for purposes of computation.

"Fourth, to confine the treatment to that part of mechanics which is common ground for the physicists and the engineer.

"Fifth, to reduce the inherent difficulties of the subject to a minimum by treating dynamics in two analogous parts—rotational and translational—such that if either one is given the other may be immediately deduced.

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